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A Strategy for Wetlands Restoration: Steps Towards Sustainable Development

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Abstract

Careless handling of wetlands and neglect of the environment will lead to unacceptable situations and problems for planned developments in ports and navigation infrastructure. Obstacles vary from unforeseen adverse impacts on nature, to resistance to planned projects and delays in project realisation, from dramatic budget overruns to projects that will not be realised at all.

Both to benefit the restoration of disturbed wetlands, as well as support new developments in port planning, an equilibrium between interests must be found. PIANC Envicom's Working Group 7 has prepared ecological and engineering guidelines for wetland restoration relating to the development, operation and maintenance of navigation infrastructure. This paper is based on the findings of the working group's report with experiences in Europe added. It outlines the overall process of wetland restoration and how to develop a planning strategy. The examples given offer some guiding principles to balance the economic interests of the port and the ecological interests of the wetlands. A version of this paper was presented at the Wetlands Restoration Workshop October 2003, in Portland, Oregon, USA.

Introduction

Wetlands are areas of marsh, fen, peat land or water. They are among the most important and productive ecosystems on earth. Human life depends on a complete and fully functioning ecosystem. Though wetlands comprise only 6% of the world's land surface, wetlands contribute to a much greater percentage of the world's overall biological productivity and water resource functions. The importance of wetlands cannot be overestimated. They have fundamental ecological functions as regulators of water regimes, water storage, flood prevention and natural water treatment.

Wetlands provide the local environment for the typical submerged water communities in the sea, river, marsh or lake. Many species of birds and mammals, fish, amphibians, shellfish and insects rely on wetlands for food, water, and shelter, especially during migration and breeding. At a large scale, wetlands contribute to atmospheric processes and are part of the global cycling of nitrogen, phosphorous, sulphur and carbon. In short, wetlands are essential as habitats supporting a rich biodiversity, which is recognised world wide as a key resource for sustainable development. Apart from the above-mentioned ecological and scientific functions of wetlands, many areas have also an important economic and social value that should be conserved.

The Convention on Wetlands of International Importance (RAMSAR Convention, 1971) was the first of the global intergovernmental treaties on conservation and

Table I. Wetland functions.

Biological	Productivity
	Diversity
	Habitat provision
Physical	Flood protection
	Shoreline protection
	Dissipation of erosive forces
	Sediment trapping
	Water storage
	Recharge of groundwater aquifers
	Sources, sinks and transformers of materials
Chemical	Pollution control
	Water quality improvement
Social	Resource for research
	Supply of baseline data
	Aesthetic and heritage value
	Opportunity for recreation and education
Economic	Food production (rice, fish, shellfish, etc)
	Water extraction
	Mining
	Oil and gas extraction

wise use of natural resources (Figure 1). The RAMSAR Convention defines wetlands as "Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres".

Five typical wetlands can be identified:
- Estuaries, where rivers meet the sea and salinity is intermediate between salt and freshwater (e.g. deltas, mudflats, salt marshes);
- Marine, not influenced by river flows (e.g. shorelines and coral reefs);
- Riverine, land periodically inundated by river overtopping (e.g. water meadows, flooded forests, oxbow lakes, river forelands);
- Palustrine, where there is more or less permanent water (e.g. papyrus swamp, marshes, fen);
- Lacustrine, areas of permanent water with little flow (e.g. ponds, kettle lakes, volcanic crater lakes).

At the moment 138 countries have signed the RAMSAR convention. The contracting parties commit themselves, amongst other things, to the following obligations:
- List their own locations of particular interest on the basis of its ecology, botany, zoology, limnology or hydrology.
- Designate at least one site that meets the RAMSAR criteria for inclusion in the List of wetlands of international importance.
- Include wetland conservation within their national land-use planning and promote the conservation of wetlands in their territory.
- Develop national wetland policies. Any loss of wetland should be compensated for by creation of new habitat.
- Establish nature reserves on wetlands and promote training.
- Consult with other contracting parties about the implementation of the Convention, about transfrontier wetlands, shared water systems, shared species and development aid for wetland projects.

The "List of wetlands of international importance" contains at the moment 1367 areas with a total surface of 120.5 million hectares.

Problem Statement

Despite all their important functions, wetlands are under severe pressure from a whole range of human activities. Human-induced impacts on wetlands have included both wetland alteration and wetland destruction. Significant wetland alteration still continues, as a result of regulated and non-regulated activities, pushed by the need for navigation infrastructure and dry land for industry and housing. Impacts are caused particularly by hydrologic and morphological modification, sedimentation and hydrodynamic process alteration, such as water abstraction, the filling in of water bodies, eutrophication and pollution by pesticides and other

Figure 1. What steps should be taken to come to a balanced solution? What steps would protect the Irediparra gallinacean, also known as Jassana, in an undisturbed wetland? And how can we reach this goal and maintain our own economic interests?

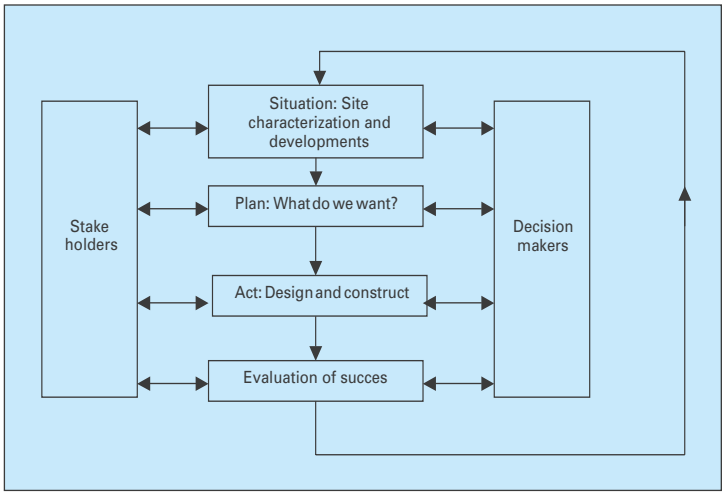

Figure 2. Basic steps in strategic planning.

contaminants, peat mining, mineral extraction, and more natural causes such as drought, global climate change and rising sea levels. Wetlands are being lost throughout the world at an alarming rate. Most estimates suggest that about 50% of the world's wetlands have disappeared in the last few decades (Table II).

The International Navigation Association (PIANC) realised that both for the benefit of the restoration of disturbed wetlands as well as for new developments in port planning it is important to find equilibrium between the several interests. To that end PIANC tasked Working Group 7 to develop "Ecological and engineering guidelines for wetlands restoration in relation to the development, operation and maintenance of navigation infrastructure". The strategy should outline how to enable ports to grow in a sustainable way without destruction or degradation of nearby wetlands. A situation should be reached where navigation can continue to function over the years to come without a negative environmental impact. This paper is based on the findings of the report of the PIANC working group. To clarify the guiding principles some European experiences have been added. These include the most important wetlands of The Netherlands, the Wadden Sea. The Wadden Sea is an internationally important rest area for migrating birds. Also the area between the islands of South Holland contains an important ecosystem with various protected species. The Netherlands has also many big and small rivers with various ecological functions. The rivers in this area have important social and economic functions as well, with many small and big inland ports.

Strategic Plan

A strategic plan is an excellent means to assure the sustainable development of ports as well as environmentally sound wetlands. The strategy should aim at attaining equilibrium between the economic interests of navigation and trade with the ecological interest of the wetland. It provides an overview of the realistic goals, the means to reach these goals, the planning time and the resources needed. It incorporates the results of research and studies. In this way a strategic plan is also an essential element in obtaining finance and all legal permits, which are necessary for implementation. It lays the foundation for communication to the public and it is the basis for an agreement among the parties involved. The strategy should be based on the guiding principle of sustainable development.

Wetland restoration planning is not different from other infrastructure planning (see Figure 2). What makes wetland restoration special is the complexity of biotic and a-biotic issues, and the hydrological, nautical and ecological aspects involved. Moreover there are many stakeholders with different interests, in addition to spatial planning, to environmental and social issues and to legal requirements. Another important obstacle is that the values of wetlands are not easily measurable in terms of money. Consequently, an objective weighing of pros and cons is hardly possible. Wetland restoration is mostly tough going and subject to many discussions.

The First Step of the Strategy: Site Characterisation

The first step in strategic planning is the characterisation of the existing condition and the impact of navigation and traffic development on the environment. Knowledge of the facts, data and quantification of the current state form the baseline of each project. An analysis of the foreseen or required developments in navigation and trade in the future is part of the characterisation. However, the outline of the situation should not only include the maritime elements. Other aspects should be brought together as well. For instance, both the economic dynamics of the port as well as the ecological dynamics of the wetland are important, and the human environment should not be forgotten. The quality of life of the people who live, work and have their leisure time in the neighbourhood must be considered. National and international legislation plays a role too.

Table II. Wetland loss in some countries.

Country	Period	% loss of wetlands
Netherlands	1950-1985	55
France	1900-1993	67
Germany	1950-1985	57
Spain	1948-1990	60
Italy	1938-1984	66
Greece	1920-1991	63
USA	1990-2000	800 to 1600 km^2 per year

The first step of the strategy must result in an overview of the current situation and the expected developments. Analyses and evaluation of the situation leads to the identification of constraints and bottlenecks to overcome. It gives insight into the required situation to strive for.

Relevance of setting goals

Strategic planning and setting goals and objectives in a wise way is complex and often frustrating. Predictions of the impact of measures and the future situation after intervention are rather complicated and seldom reliable. A famous example of failure in goal setting is the story of the Aral Sea. Fifty years ago the Aral Sea was one of the biggest lakes of the world, located in Uzbekistan and Kazakhstan, the dry heart of Central Asia, in the centre of a large flat desert. Both countries were then part of the former Soviet Union. Two main rivers, the Syr and the Amu, fed the lake. These rivers formed deltas before draining their waters into the lake. On the banks of the lake and the estuaries of the rivers and in small oases people were growing vegetables, rice and cotton. The fishing industry in and around the lake was substantial. A large area was irrigated for agricultural purposes.

Fifty years ago, however, it was decided that the cotton industry should receive a new big impetus and that the irrigated area should be greatly enlarged. To that end many new cotton plantations were built, and many new irrigation canals were excavated in order to irrigate the new plantations with the water from the afore-mentioned rivers. Huge construction works were undertaken. This changed the hydrological situation dramatically, as shown in Table III.

The consequences have been disastrous. The rivers Syr and Amu are almost dry long before they reach the Aral Sea. Sea level has fallen by more than 16 metres. The shoreline has receded up to 120 km from its former shore. The velocity and the size of the ecological changes in the area of the Aral Sea are unique in human history. The scale of the biological, social and economic consequences of these changes in the area around the Aral Sea is catastrophic. Fifty year ago thousands of tons of fish were brought ashore by the fishing fleet of the Aral Sea. Nowadays the salt content of the lake is so high that fishing is no longer possible at all. At the moment sand is replacing water and camels are replacing fishing boats. Many times the silt layers on the bottom of the dried area rise in clouds around, forming sand dunes in a desert area.

Table III. Hydrological situation of the Aral Sea.

	1950	2000
Surface	67,000 km^2	33,000 km^2
Inflow	50 km^3/year	5 km^3/year
Water level	+ 16 m	0 m
Salt content	10 g/l	28 g/l
Irrigated area	290,000 km^2	720,000 km^2

This is only one part of the tragedy. Apart from the impacts on the lake itself it turned out that the influence on the climate in the surrounding area is alarming as well. This was an unforeseen consequence of the infrastructure works carried out. Another unforeseen problem was the flow through the irrigation canals.

The water of the rivers was meant to flow through the excavated canals to the new plantations. However, the water in the irrigation canals didn't flow at all. It sank away in the sand of the newly dredged canal through the desert. This caused the origin of many small pools and lakes and consequently the uncontrolled growth of algae, duckweed, water hyacinth and other plants. The water got stuck in the water plants and did not even reach the planned agricultural areas. The water became stagnant and as such a perfect breeding ground for the development of the malaria mosquito.

Various measures were taken in order to remove the overgrowth of water plants. Firstly draglines and other equipment were used for the removal of the unwanted overgrowth. However, the power of growth was so high that they did not manage to clean up the canal. Then they tried to dehydrate the water plants. To that end chemicals were brought into the water of the canals. And indeed algae, duckweed, water hyacinth and water plants died. The water began to flow and could reach the agricultural area. However, the chemicals used turned out to be very resistant and did not break down before reaching the cotton cultivation. The result was that the harvest failed year after year. At the moment half of the formerly cultivated area is spoiled by the chemicals.

There is, however, a small ray of hope in this story. Finally, after many years of struggle for canals without the overgrowth of water plants and with clean streaming water this problem has been solved by the introduction of an ecological solution. In 1972 the hypophthalmichthys molitrix or silver carp was introduced into the mouth of the canals. These fishes graze most of the water plants from the bottom of the canals and in this way they provide a free flow of the water.

With this example we have learned that economy is not the only truth. We cannot live by money alone. For the survival of human beings it is essential to consider the likely environmental consequences of constructions and developments in a careful and proactive way. Moreover, ecology turns out to be a good partner and can be of help in the realisation of solutions. A guiding principle is to strive for an equal balance between economy and ecology.

Figure 3. The Port of Delfzijl illustrates the strong relation between the port and the wetlands of the Wadden Sea: Navigation and shipping, agriculture and fishing, industrial activities, recreation, nature organisations and the people living in the urban environment. The Wadden Sea is a shallow wetland along the coast of The Netherlands, Germany and Denmark, with a length of more than 500 km. It is the most important tidal wetland of Europe.

Other lessons can be learned from the above example. The first lesson has to do with the role of decision makers. It turns out that the role of decision makers is very important. Decisions are taken by public officials, by policymakers and other regulatory parties. They base their decisions, however, on the input of managers and researchers and on the remarks of various other parties. Thus good communication with the decision-making partners is essential from the very first start of the project and during each following phase of the project.

The second lesson has to do with the many different parties that have an interest. For instance the port related industry, but also the fishing industry, recreation, drinking water supplies, nature and the countryside. And so there are local people, there are NGO's, organizations for the protection of the environment, safety specialists; there is the agricultural sector, the industrial sector and many other parties. They all have their own concern in the wetlands or in port development or in both. During the whole process it is essential to derive a policy, in which the views and interest of all stakeholders have been integrated. In other words: Participation from the very beginning.

Figure 2 shows two different lines of interaction. Involving interested parties at an early stage will allow each party to bring in their concerns and experiences. This helps to ensure that steps are taken and studies are made in accordance with the requirements of stakeholders and decision makers. In this way the management of port and navigation channels gets the opportunity to develop and resolve issues in a constructive manner rather than possibly provoking a formal confrontation at a public enquiry.

The Second Step: Setting Goals and Objectives

The second step of strategic planning is: Plan the required situation. A realistic problem definition, as defined in the foregoing stage, is essential to set goals and objectives. This is one of the most difficult activities of strategic planning. There is not one approved manner to set goals. It depends largely on the local situation, where different conditions can exist.

a. Disturbance in the current state
Are natural characteristics disturbed in the current state; is there a need for improvement of the existing situation? The objective should be focused on a better management of the wetland and a better integration of navigation purposes and ecological purposes.

Two examples will illustrate this. The first one is a wetland that had become a waste dump. In this case the required situation is a wetland without pollution and first of all a plan must be developed to clean up the site in cooperation with stakeholders and decision makers. Moreover, in view of future generations, a management plan must be developed to prevent future waste dump on the site.

The second example is related to salt penetration. Deepening navigation channels for the increasing draught of ocean-going vessels will result in an increase of the intrusion of salt water from the sea. Freshwater withdrawal from waterways also causes the salt content to rise. This results in higher salt concentration in the plain. If the salt content is too high trees and other plants in the plain will die. To remedy this situation a management plan must be developed in which the hydrological situation is improved substantially.

Regarding the rehabilitation of the damaged wetlands of the above mentioned cases will learn that many centuries were required to develop the habitat in wetlands and many years and a great deal of effort, time and money will be needed to restore a degraded habitat or to create a new one. The first priority should, therefore, be focused on actions to avoid destruction or degradation of wetland functions and values.
The guiding principle is: Prevention is better than cure.

b. Disturbance in the future
Will natural characteristics be disturbed in the future when navigation developments take place; will the disturbance be permanent or temporary? The objective should be focused on measures to be taken for temporary protection during construction and for permanent management of the wetland afterwards. The following example will illustrate this.

For navigation purposes it is proposed to connect two rivers with each other. At the moment each river will have its own ecosystem and related species.
The construction of the canal between these rivers will introduce aquatic organisms from one river into the other river. This might have serious ecological impact. Sometimes the alien species are so successful that the original aquatic species fully disappear. In practice between 5 to 20% of the established immigrant species are able to develop populations dense enough to turn them into pests. Solutions and protective measures should be included in the planning phase of the project. To reduce the migration of species the installation of migration barriers should be considered. For instance deterrent electrical systems could be introduced. In both regions monitoring and control is essential to prevent a reduction in the biodiversity of the ecological system.

c. Measures are insufficient
Are possible measures not sufficient to compensate the impact of navigation development by good management? In this case managers should prove which social needs urge for these navigation developments. The objective should be focused on minimising adverse effects by limiting the degree of action and on alternatives with less impact on the existing wetlands.

The social importance of wetlands is illustrated by the small Dutch port Delfzijl, situated on the Wadden Sea, a wetland along the coast of The Netherlands, Germany and Denmark. Figure 3 shows clearly the different interests in a sound Wadden Sea. Any major reduction in the environmental diversity of the Wadden Sea may restrict the scope for future discovery and development. The nature areas near the living areas are a basic condition for sustainable development and for the promotion of the quality of life of the people who work and live there. The guiding principle is: Ecological values benefit socio-economic values.

d. Adverse impacts are inevitable
Are there social reasons that would necessitate developments which would adversely affect a wetland? The focus should be on rehabilitating or restoring measures, on preservation or maintenance operations that could reduce or eliminate adverse effects. Studies and research should incorporate an environmental impact assessment. An alternative should be selected that assures that all possible measures are taken.

The brief history of the development of the port of Rotterdam illustrates this point. A new harbour area was urgently needed to enable the growth of the container, distribution and petrochemical sectors and to meet future industrial housing requirements. Space is very scarce in this densely populated area. There is no room left for new container terminals. Thirty years ago a new port area of 30 km^2 had already been reclaimed from the North Sea, the so-called peninsula Maasvlakte. The only way to create a new port area for port development was to reclaim for the second time a peninsula in the North Sea: Maasvlakte II.

From a morphological point of view the best option for land reclamation was to incorporate the sandbanks in the coastal zone into the developments of the future port area. Figure 4, a satellite photo from 1985, shows

Figure 4. Satellite photo, of the morphological situation in the coastal zone of Rotterdam, 1985, with the reclaimed area, the Maasvlakte of Rotterdam at the top of the photo. North of the Maasvlakte lies the deep fairway to Rotterdam. South of it are the islands of South Holland. Natural developments have caused the forming of sandbanks along the coastline.

Figure 5. In the 1970s a design for the creation of a new port area in the North Sea made use of the forces of nature. This idea has never been realised.

that nature had already started the formation of a new peninsula south of the Maasvlakte. The sandbank is orientated to the southwest and runs roughly parallel to the coastline. Consequently the first designs were related to these natural developments of the coastal zone. Figure 5 shows a design made about 25 years ago. It was one of the first alternative designs. It made use of the forces of nature in an optimal way. From the existing Maasvlakte the planned peninsula runs almost parallel with the coastline. With this alternative there is no need for hard constructions, like rocky dams and breakwaters.

However, man cannot live by morphology alone. During the dialogue with stakeholders ideas might change. Moreover, various conventions and agreements must be taken into account. Looking at this particular site, decades of negotiations with the many stakeholders in the region resulted in two strong lines on the map. The first one is the so-called "demarcation line". This line was appointed in consultation with nature organisations and people living in the area of Voorne, in order to minimise the effects of the reclamation to the dune reserves. "No port and related industrial activities shall be developed south of the ´demarcation line`." The second line is the so-called "Haringvliet line". This came into being as a result of the obligations of the RAMSAR convention. "No port and related industrial activities shall be developed west of the 'Haringvliet line'."So, the only space left for port development is the coloured area jutting out into the North Sea (see Figure 6).

Figure 6. Area available for land reclamation in the coastal zone of the port of Rotterdam. As a result of legislative requirements the so-called Maasvlakte II must be located north of the "demarcation line" and east of the "Haringvliet line".

e. Requirements of conventions

Are there local, national or international legislative requirements relevant? The focus should be on compliance with all legislative requirements.

In addition to the obligations of the RAMSAR Convention, European legislation sets its own requirements, for instance the European Directive on the conservation of wild birds. This Directive establishes a complex scheme for the protection of migratory and other wild birds and their habitats. This is to be done by preserving, maintaining or re-establishing a sufficient diversity and area of habitats; that is by creating protected areas, managing habitats inside and outside protected areas, re-establishing destroyed biotopes and creating new ones. The Birds' Directive has designated various areas in Europe for the protection of birds. For instance The Netherlands has designated 79 areas for the protection of wild birds. In addition to the protected areas, the Directive includes a list of protected birds.

Moreover, there is the European Directive on the conservation of wildlife and natural habitats. In the framework of this so-called Habitat Directive, 89 areas have been designated as protected areas in The Netherlands. The habitats directive sets rules for the protection of natural habitats that are of importance for wild flora and fauna. Various flora and fauna species that are to be strictly protected are listed in appendices. The above-mentioned RAMSAR Convention and European Directives are not the only regulations. International concern has lead to a series of conventions to protect the environment. National and international legislation oblige to consider the consequences of port development. In short: one has to comply with the requirements of conventions.

f. Loss of ecological values
Can't adverse effects be avoided? After all appropriate and practical measures have been taken. The focus should be on compensation measures to be taken by replacing or providing substitute resources or wetlands.

To illustrate this, let's go back to the plans of the port of Rotterdam for the creation of the peninsula Maasvlakte II. In May 1998, a key decision-making process for the port extension of Rotterdam was started. Environmental impact assessments were carried out. Public participation was essential in this process. Emphasis was placed on a transparent decision-making procedure in which the wishes of the community and the potentials of nature development were coordinated. This turned out to be both a technical and a social process. One of the most important aspects in this process was the introduction of a transparent process involving all interested parties and good effective lines of communication. In other words: show and evaluate all impacts.

The above-mentioned guiding principle is even more valid as almost all large infrastructure works have adverse effects on the environment. In such cases, any loss of ecological values and each significant impact on the natural environment must be compensated for. Therefore it is advisable to start thinking about compensation from the very beginning of the project. For instance, for the future port area of Rotterdam it has been decided that the 10 km^2 of industrial area shall be compensated by 7.5 km^2 nature and recreation area. In this way nature and environmental organisations agreed to the port expansion project at an early stage. In the agreement Rotterdam is committed to a maximum level of mitigation and the improvement of the city's built environment. The compensatory measures include the creation of a new coastal dune area and wetlands as well as a marine reserve within the estuary. In December 2003 the Dutch government decided to participate in the investment of the project.

The Third Step: Implementation

Implementation of the programme includes determining methods to reach the goals and to incorporate them into land-management strategies. In other words: Design and construct. The key process of the design stage is the draft of the required hydrology, the creation of the layout and landscape and its visual quality, the training of the people involved and the procedures to monitor and control. The large variety of environmental conditions connected with wetlands requires that the local conditions be taken as a starting point for the technical design of wetland functions.

Hydrology is a key factor in the design. Understanding of the hydrologic features and the relations between hydrology and the required habitat is essential. The key being that nature itself cannot be constructed. Therefore the design should address the conditions for the living species to survive, rather than the ecosystem itself. The environment should be created so that the desired ecosystem can function and regenerate in a healthy manner. The ideal goal is a self-sustainable ecosystem with minimal maintenance. By taking advantage of natural developments the cost will be minimised. Monitoring the natural developments and adapting the design according to the findings is good practice.

The key process in the construction stage is the realisation of the required situation. Monitoring and control of the environmental impact during construction should be an integrated part of the programme of supervision. However, wetland restoration projects might show unforeseen occurrences and develop beyond control. For those reasons, modifications may be necessary to accommodate these unforeseen developments and to take advantage of newly acquired knowledge or resources. In other words the principle of "adaptive management" should be applied to wetland projects.

For the most part, dredging will be required for the realisation. One of the main problems in dredging is the re-suspension and settlement of sediment and consequent turbidity caused by the dredging operations. These can have impacts on the diversity of flora and fauna and on their growth rates. As the sediments are dispersed and then resettle, animals living on and in the seabed can be smothered causing death. Much of the "clean" dredged sediment is returned to the river or seabed at a different location, often many kilometres from the dredged area, thus the effects indicated above will occur at both locations. This holds especially true when the dredged material is polluted. Contaminated sediments, which were "locked" into the bed, can be released by the dredging process. This may increase the levels of contaminants available to be taken into living organisms. In such cases special environmental dredging techniques may be used that prevent or limit the dispersion of sediment.

The deliverables of the third step will lead to a sound wetland ecosystem as well as to sustainable development of the navigation system. The purpose of all the mentioned activities is the implementation of wise use of wetlands in consultation with all stakeholders.

The Final Step: Evaluation of Success

The final stage of the strategy is the post-construction site management and the evaluation of success. An environmental assessment and feedback to the result of activities must be carried out. If the results of the review indicate that the methods are not achieving

the required goal, measures should be taken to improve performance to the required level. This feedback loop can continue until the environmental audit indicates that the goals have been achieved. A regular time interval for this feedback is recommended. Attention should be given to an approach making use of reference and target situations. This provides a policy tool for translating the ecological data from the past and present into practical and testable objectives. Such references and ecological starting points may also give others a more objective picture of the choices made.

The process of management should however, not be too strict. It should be regarded as a continuous, long-term process. Managers must adopt a flexible approach that will allow them to respond to the legitimate interests of stakeholders and adapt to the uncertainties of the nature world. The planning process has to be adaptive and dynamic. The plan must change or evolve to meet varying factors both on and off the site. The performance criteria developed should be based on sustainable development with a minimum maintenance. This type of adaptive management is a good example of wise use of wetlands.

The deliverables of the evaluation are related to the rates of failure and success. To measure the rate of success a monitoring programme must be set up. The results of the measurement are to be evaluated against the target for each goal. The review of the results will give inside information on both the effectiveness of the measures taken as well as on the effectiveness of the management system. This will indicate any changes required to the goals and actions. This process of evaluation and feedback will be of guidance to the concept of continual improvement of methods and performance.

Conclusions

A strategic plan for wetlands restoration should consider various guiding principles:

- Sustainable development: Integration of navigation infrastructure and wise use of wetlands.
- Balancing ecology and economy.
- Participation of stakeholders from the very beginning.
- Prevention to avoid expensive remedial actions is better than cure.
- Restoration of ecological values will benefit socio-economic values
- Comply with the requirements of national and international conventions.
- Show and evaluate all impacts in a transparent way with decision makers and stakeholders.
- Adapt management to accommodate unforeseen developments and take advantage of newly acquired knowledge.
- A good strategy is a must.

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